Going NUTS for Network Testing

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IP Network Automation

The Questions

1. What is testing?
2. What are the different types of testing?
3. How does testing apply to network design and operations?
4. How can we test the network?

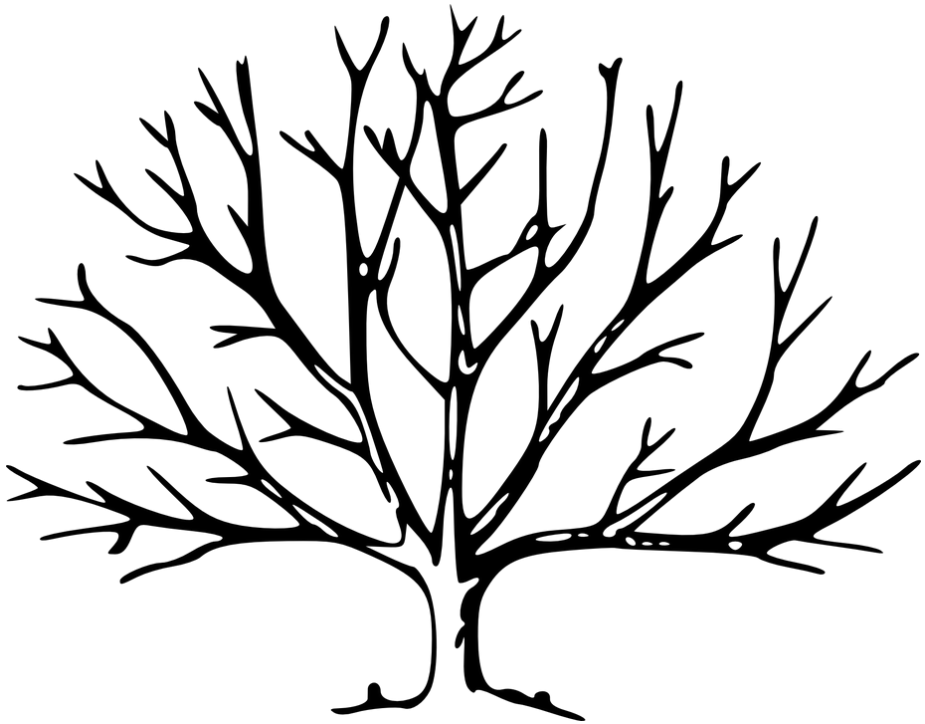
What is Testing?

What is Testing?

Software testing is the process of evaluating and verifying that a software product or application does what it's supposed to do.

(https://www.ibm.com/topics/software-testing)

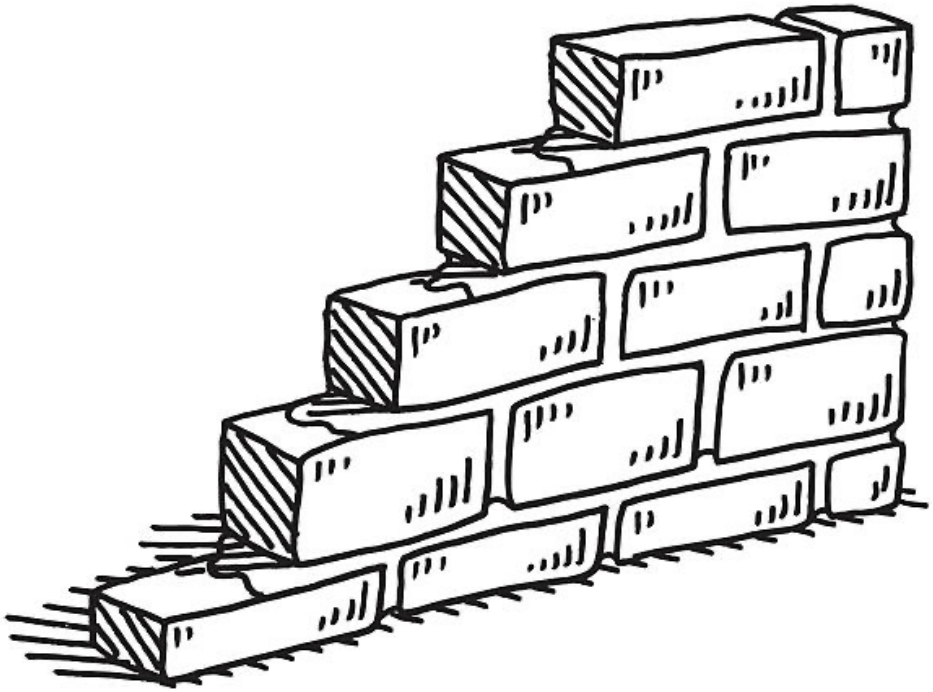
- Taking a system, giving it known inputs and inspecting the output.
- Systems, especially software can be infinitely complex with lots of branching logic.
- Testing coverage is about ensuring that all branches of a system are traversed in the testing process, ensuring all "code paths" are tested.



Types of Testing

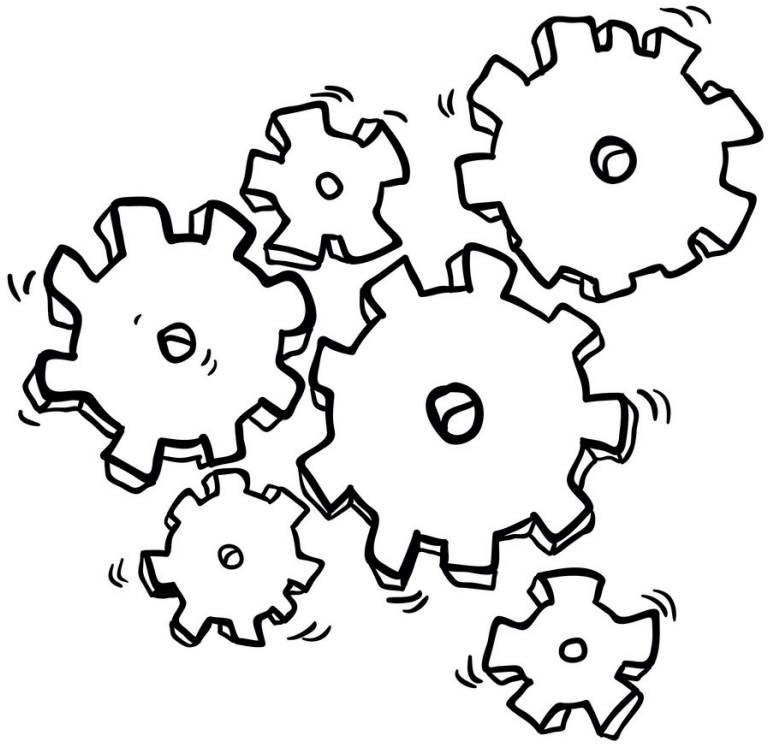
Unit Testing

- Designed to test the smallest components of a system in isolation.
- Removes dependencies on other parts of the system and carefully controls the inputs.
- E.g. A method to take some JSON and return a BGP Peer configuration stanza. Known input = Known output.
- Stubbing and Mocking are common in unit tests to ensure isolation.



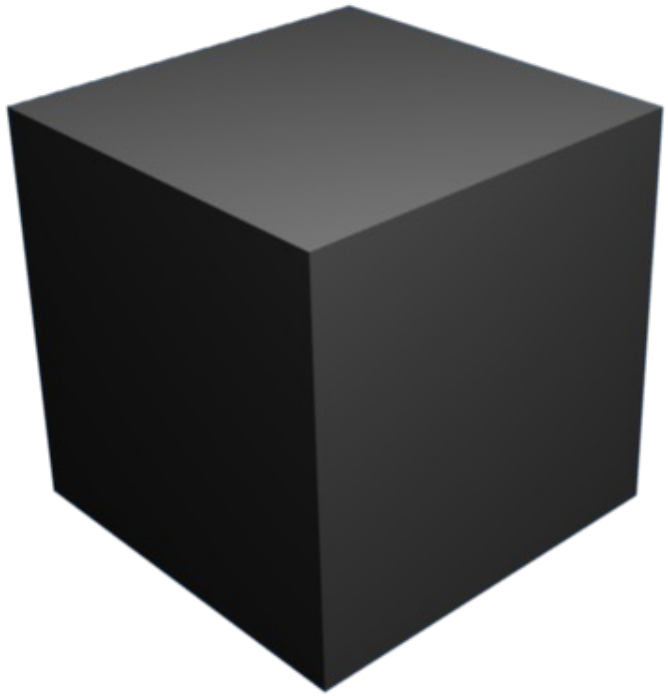
System Testing

- Tests on a complete system, usually used to test end-to-end function of a given feature-set.
- Also referred to as “E2E” or “Integration testing.
- Examples:
  - Given a device name and a known set of inputs, a system can generate a complete device configuration (that’s correct).
  - Given a device name, a system can act against a device and disable all BGP neighbours.



Blackbox Testing

- Blackbox meaning we're not able to introspect the internal implementation details.
- In the functional sense, this is about externally interacting with the system passing a known input and inspecting the output.
- E.g.
  - Testing a vendor's NOS is typically Blackbox Testing. Little control over the internals, only a promise of input → output.




How does testing apply to
Network Design and Operations?

Typical Network Design Use-Cases

- Migrating between vendors
- Migrating from one technology to another
  - RSVP + MPLS → SRv6
  - VPLS over MPLS → EVPN-VXLAN
- Design to a pre-defined specification
  - Internal Specification, RFC, IETF, IEEE, TMF, BBF…
- Iterative Design aka “Figure it out as we go”

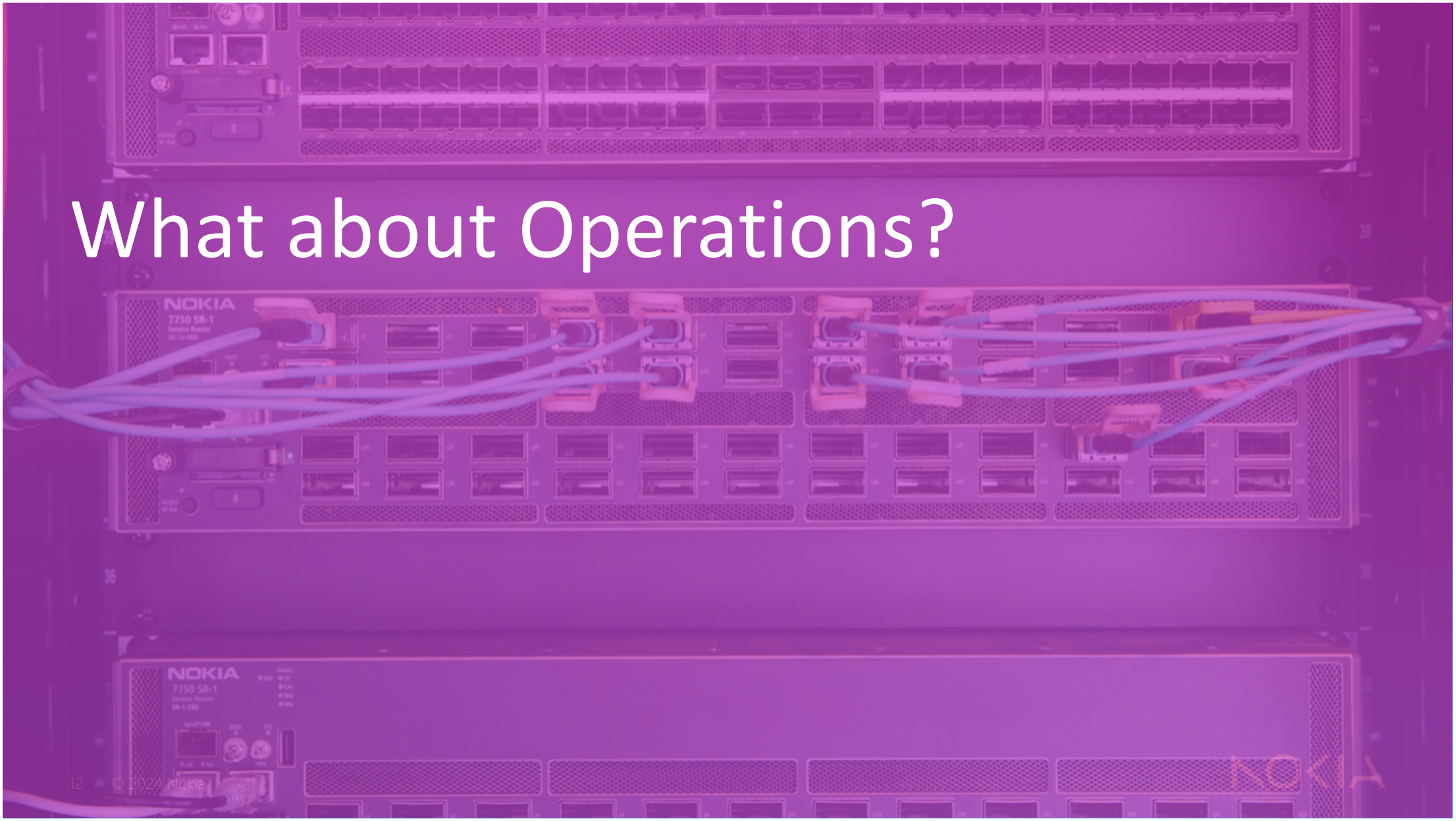
Software Development Thinking

- All these processes could benefit from software-development thinking.

- Design Validation
  - Proof-of-Concept validation against a specification → Unit Testing
  - An end-goal is met after a given iteration → Unit Testing

- Implementation Validation
  - One network does the same thing as the other → Systems Testing
  - One technology does the same as the other → Blackbox Testing

What about Operations?



Network Baseline

- Networks tend to have a baseline of expected functionality (known outputs)
  - Certain interfaces up with protocols enabled
  - Certain learned protocol states or neighbours
  - Certain traffic levels

- As Network Engineers we often “feel” this – why not codify it?

- Why not capture network state and check it against a different reality! → Unit Testing

Software Upgrades

- Software Upgrades start with…
  - Known, good, state then…
  - Structured changes are implemented…
  - We expect a similar (possibly different) end state!

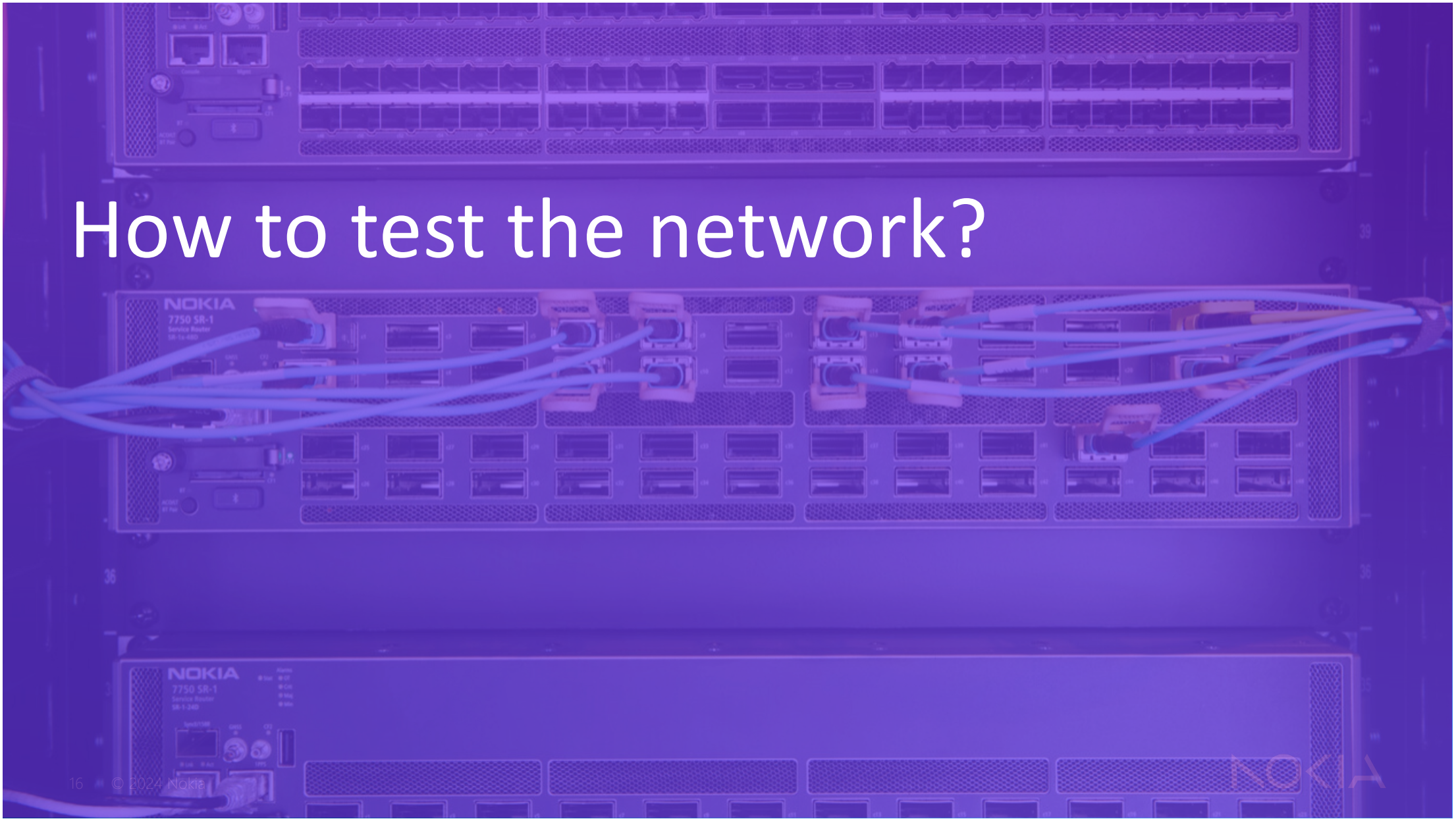
→ System Testing

Customer Impact

- Making changes to underlying infrastructure that affects customer services.
  - Transport mechanism, technology or device might change
  - Customer service is expected to stay consistent

→ Blackbox Testing

How to test the network?



NUTS – Network Unit Tests

- Open Source Software that enables unit testing using Python's excellent pyTest framework.
- Enables network-focused use-cases by stitching Nornir with a programmatic test framework.
- Comes with pre-packaged NAPALM-integrated testing examples.
- Well documented examples with easy customisation.
- Ability to drop to native Python for advanced cases.

```
- test_class: TestNapalmBgpNeighbors
  test_data:
  - host: dcfabric-syd1-pd1-l1
    is_enabled: true
    is_up: true
    local_as: 4210000101
    local_id: 10.0.0.24
    remote_as: 4210000011
    remote_id: 10.0.0.24
  - host: dcfabric-syd1-pd1-l1
    is_enabled: true
    is_up: true
    local_as: 4210000101
    local_id: 10.0.0.36
    remote_as: 4210000012
    remote_id: 10.0.0.36
```

https://github.com/network-unit-testing-system

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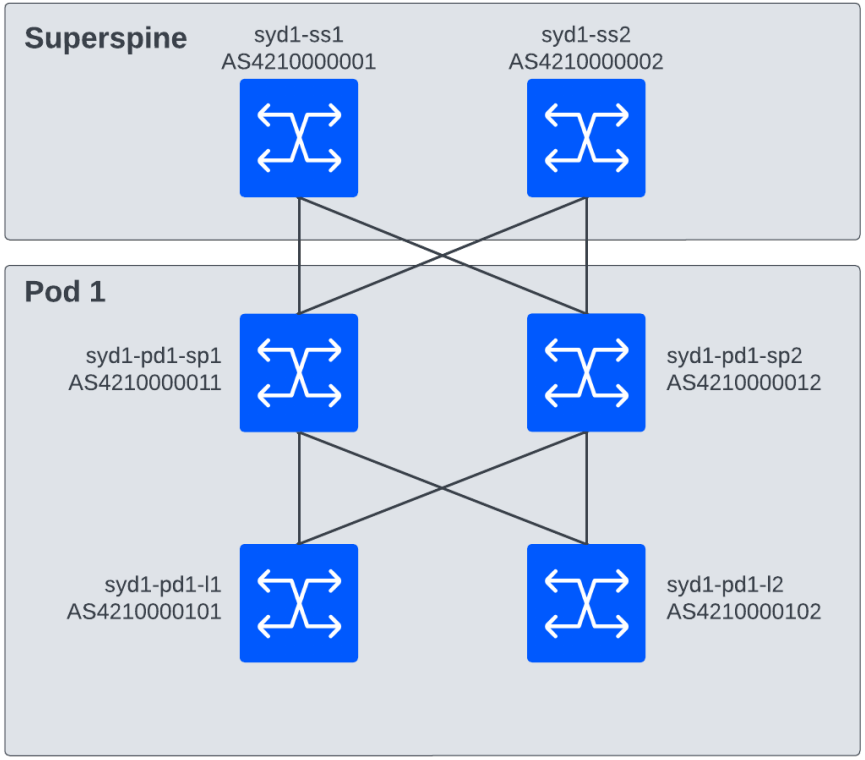
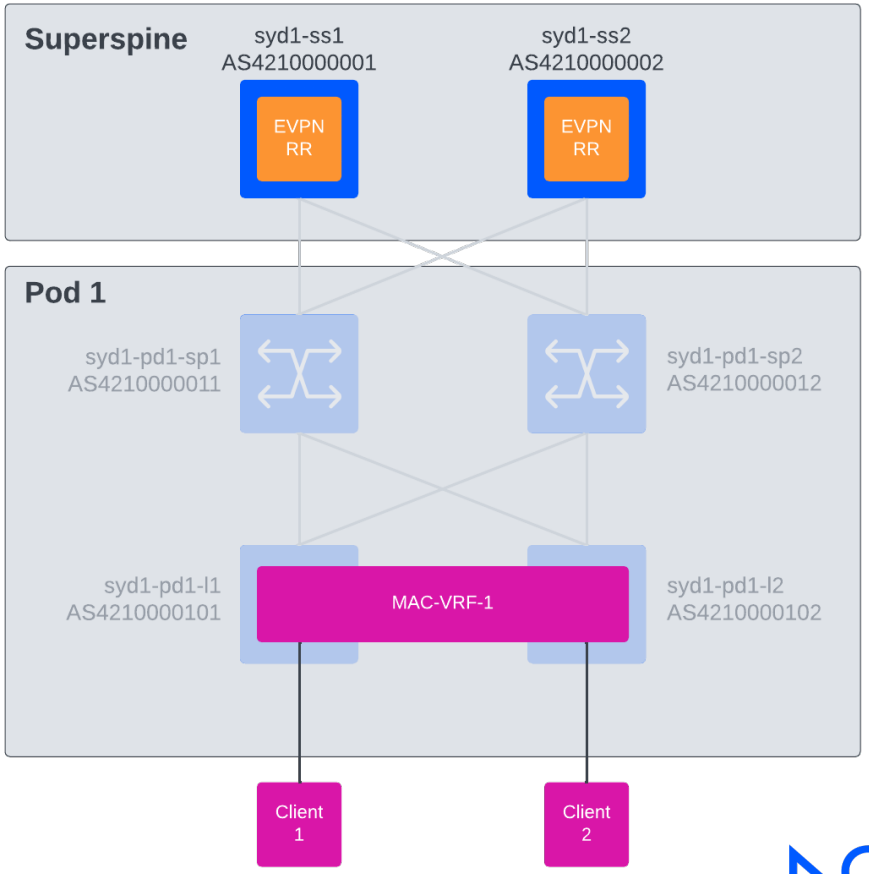
Example Network

SRLinux-based Data Centre Fabric – EVPN-VXLAN





Let’s do some Network Engineering and test along the way!

Live Demo 

Takeaways

- Testing methodology isn't just about software development.
- Iteration of ideas, designs and processes need feedback-loops, testing concepts can enable this.
- Improve operational process, especially for repetitive tasks.
- Catch problems before they occur, especially if they've occurred before!
- Improve your design process and create a framework for how you think about network design.


Questions?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Static Demo Slides

Containerlab Network

```
(venv) root@containerlab:/home/tim/ausnog-2024# clab inspect
INFO[0000] Parsing & checking topology file: dcfabric.clab.yaml
+---+-------------------------+--------------+-----------------------------------+-------+---------+----------------+----------------------+
| # |          Name           | Container ID |               Image               | Kind  |  State  |  IPv4 Address  |     IPv6 Address     |
+---+-------------------------+--------------+-----------------------------------+-------+---------+----------------+----------------------+
| 1 | dcfabric-graphite       | 1e8cc9abdaa7 | netreplica/graphite:latest        | linux | running | 172.20.20.12/24 | 2001:172:20:20::c/64  |
| 2 | dcfabric-syd1-client-l1 | 93ac8297d594 | ghcr.io/hellt/network-multitool | linux | running | 172.20.20.19/24 | 2001:172:20:20::13/64 |
| 3 | dcfabric-syd1-client-l2 | e2fdf5f68a60 | ghcr.io/hellt/network-multitool | linux | running | 172.20.20.11/24 | 2001:172:20:20::b/64  |
| 4 | dcfabric-syd1-pd1-l1    | e70807910d34 | ghcr.io/nokia/srlinux:latest      | srl   | running | 172.20.20.20/24 | 2001:172:20:20::14/64 |
| 5 | dcfabric-syd1-pd1-l2    | 074e64af64ea | ghcr.io/nokia/srlinux:latest      | srl   | running | 172.20.20.17/24 | 2001:172:20:20::11/64 |
| 6 | dcfabric-syd1-pd1-sp1   | 8a0e8511bc98 | ghcr.io/nokia/srlinux:latest      | srl   | running | 172.20.20.16/24 | 2001:172:20:20::10/64 |
| 7 | dcfabric-syd1-pd1-sp2   | a1a1266dddf6 | ghcr.io/nokia/srlinux:latest      | srl   | running | 172.20.20.18/24 | 2001:172:20:20::12/64 |
| 8 | dcfabric-syd1-ss1       | ad7bd1de0614 | ghcr.io/nokia/srlinux:latest      | srl   | running | 172.20.20.21/24 | 2001:172:20:20::15/64 |
| 9 | dcfabric-syd1-ss2       | cfdb1fd28f71 | ghcr.io/nokia/srlinux:latest      | srl   | running | 172.20.20.22/24 | 2001:172:20:20::16/64 |
+---+-------------------------+--------------+-----------------------------------+-------+---------+----------------+----------------------+
```

Example Tests

```yaml
- test_class: TestNapalmLldpNeighbors
  test_data:
  - host: dcfabric-syd1-pd1-l1
    local_port: ethernet-1/27
    remote_host: syd1-pd1-sp2
    remote_port: ethernet-1/1
  - host: dcfabric-syd1-pd1-l1
    local_port: ethernet-1/28
    remote_host: syd1-pd1-sp1
    remote_port: ethernet-1/1
```

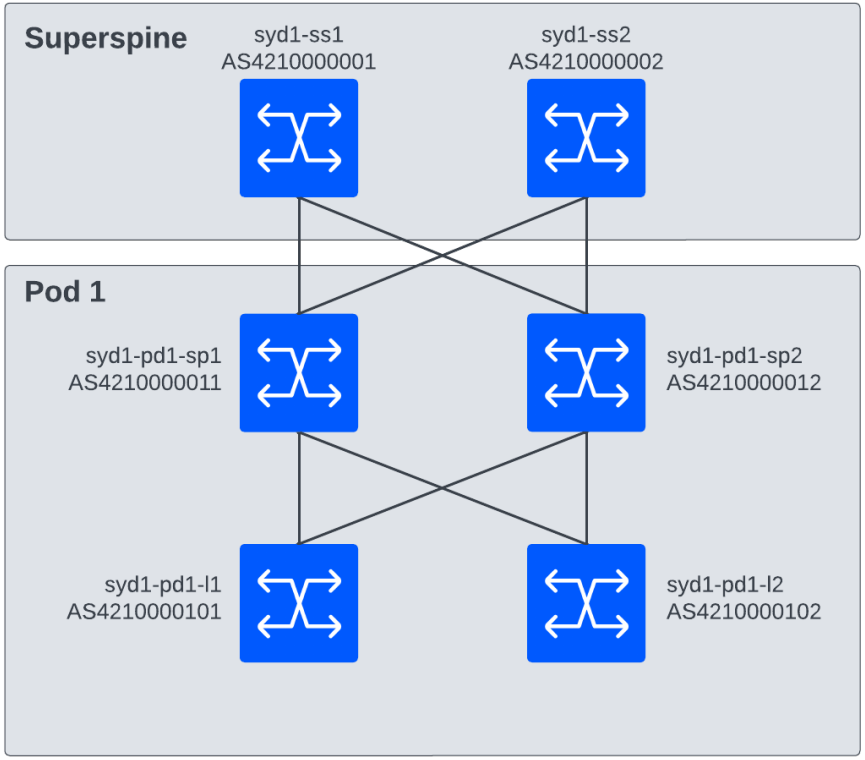
```yaml
- test_class: TestNapalmBgpNeighbors
  test_data:
  - host: dcfabric-syd1-pd1-l1
    is_enabled: true
    is_up: true
    local_as: 4210000101
    local_id: 10.0.0.24
    remote_as: 4210000011
    remote_id: 10.0.0.24
  - host: dcfabric-syd1-pd1-l1
    is_enabled: true
    is_up: true
    local_as: 4210000101
    local_id: 10.0.0.36
    remote_as: 4210000012
    remote_id: 10.0.0.36
```

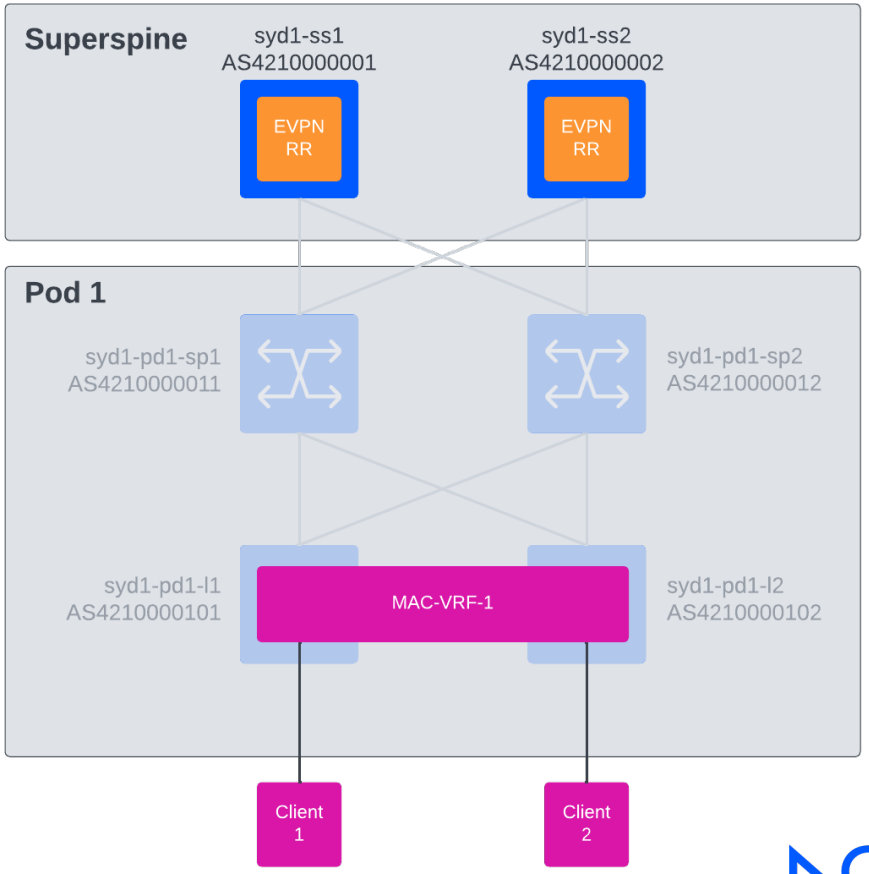
Test Run – LLDP Neighbours

```
(venv) root@containerlab:/home/tim/ausnog-2024/nuts# pytest -v ./tests/test_basic_lldp_neighbours.yaml
Test session starts (platform: linux, Python 3.10.12, pytest 7.4.4, pytest-sugar 1.0.0)
cachedir: .pytest_cache
rootdir: /home/tim/ausnog-2024/nuts
configfile: pytest.ini
plugins: nuts-3.4.0, anyio-4.4.0, sugar-1.0.0
collected 4 items

 ../venv/lib/python3.10/site-packages/nuts/base_tests/napalm_lldp_neighbors.py::TestNapalmLldpNeighbors.test_remote_host[dcfabric-syd1-pd1-l1_0] ✓      25%
 ../venv/lib/python3.10/site-packages/nuts/base_tests/napalm_lldp_neighbors.py::TestNapalmLldpNeighbors.test_remote_host[dcfabric-syd1-pd1-l1_1] ✓      50%
 ../venv/lib/python3.10/site-packages/nuts/base_tests/napalm_lldp_neighbors.py::TestNapalmLldpNeighbors.test_remote_port[dcfabric-syd1-pd1-l1_0] ✓      75%
 ../venv/lib/python3.10/site-packages/nuts/base_tests/napalm_lldp_neighbors.py::TestNapalmLldpNeighbors.test_remote_port[dcfabric-syd1-pd1-l1_1] ✓     100%

Results (1.78s):
       4 passed
(venv) root@containerlab:/home/tim/ausnog-2024/nuts#
```

Example Network

SRLinux-based Data Centre Fabric – EVPN-VXLAN





Pre-State - Building

```
# if "__name__" == "__main__":
hosts = ["dcfabric-syd1-pd1-l1", "dcfabric-syd1-pd1-l2", "dcfabric-syd1-pd1-sp1",
        "dcfabric-syd1-pd1-sp2", "dcfabric-syd1-ss1", "dcfabric-syd1-ss2"]
driver = get_network_driver('srl')

tests = []

for host in hosts:
  device = driver(host, 'admin', 'NokiaSrl1!', 10, {"jsonrpc_port": 80, "insecure": True})
  device.open()
  bgp_neighbors = device.get_bgp_neighbors()
  network_interfaces = ["ethernet-1/1", "ethernet-1/2", "ethernet-1/27", "ethernet-1/28"]
  interfaces = {k: v for k, v in device.get_interfaces().items() if k in network_interfaces}
  lldp_neighbors = device.get_lldp_neighbors()
  device.close()

  tests.append(build_nuts_bgp_neighbours_tests(bgp_neighbors, device))
  tests.append(build_nuts_interface_tests(interfaces, device))
  tests.append(build_nuts_lldp_neighbors_tests(lldp_neighbors, device))

print(yaml.dump(tests))
```

Pre-State - Output

```
- test_class: TestNapalmBgpNeighbors
  test_data:
  - host: dcfabric-syd1-pd1-l1
    is_enabled: true
    is_up: true
    local_as: 4210000101
    local_id: 172.20.1.101
    peer: 10.0.0.24
    remote_as: 4210000011
    remote_id: 10.0.0.24
  - host: dcfabric-syd1-pd1-l1
    is_enabled: true
    is_up: true
    local_as: 4210000101
    local_id: 172.20.1.101
    peer: 10.0.0.36
    remote_as: 4210000012
    remote_id: 10.0.0.36
  - host: dcfabric-syd1-pd1-l1
    is_enabled: true
    is_up: true
    local_as: 4200000000
    local_id: 172.20.1.101
    peer: 172.20.0.11
    remote_as: 4200000000
    remote_id: 172.20.0.11
  - host: dcfabric-syd1-pd1-l1
    is_enabled: true
    is_up: true
    local_as: 4200000000
    local_id: 172.20.1.101
    peer: 172.20.0.12
    remote_as: 4200000000
    remote_id: 172.20.0.12
- test_class: TestNapalmInterfaces
  test_data:
"./test_generated_prestate_fabric.yaml" 461L, 11191B
```

```
- test_class: TestNapalmInterfaces
  test_data:
  - host: dcfabric-syd1-pd1-l1
    is_enabled: true
    is_up: true
    mtu: 9232
    name: ethernet-1/1
    speed: 100000000.0
  - host: dcfabric-syd1-pd1-l1
    is_enabled: false
    is_up: false
    mtu: null
    name: ethernet-1/2
    speed: 100000000.0
  - host: dcfabric-syd1-pd1-l1
    is_enabled: true
    is_up: true
    mtu: 9232
    name: ethernet-1/27
    speed: 100000000.0
  - host: dcfabric-syd1-pd1-l1
    is_enabled: true
    is_up: true
    mtu: 9232
    name: ethernet-1/28
    speed: 100000000.0
- test_class: TestNapalmLldpNeighbors
  test_data:
  - host: dcfabric-syd1-pd1-l1
    local_port: ethernet-1/27
    remote_host: syd1-pd1-sp2
    remote_port: ethernet-1/1
  - host: dcfabric-syd1-pd1-l1
    local_port: ethernet-1/28
    remote_host: syd1-pd1-sp1
    remote_port: ethernet-1/1
```

Pre-State – Test Run (1)

```
(venv) root@containerlab:/home/tim/ausnog-2024/nuts# pytest ./tests/test_generated_prestate_fabric.yaml
Test session starts (platform: linux, Python 3.10.12, pytest 7.4.4, pytest-sugar 1.0.0)
rootdir: /home/tim/ausnog-2024/nuts
configfile: pytest.ini
plugins: nuts-3.4.0, anyio-4.4.0, sugar-1.0.0
collected 308 items

 tests/test_generated_prestate_fabric.yaml ✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓ssss✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓  17%
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Results (12.46s):
     284 passed
      24 skipped
(venv) root@containerlab:/home/tim/ausnog-2024/nuts#
```

SRLinux Maintenance Groups

```
--{ + running }--[  ]--
A:syd1-pd1-sp1# info system maintenance
    system {
        maintenance {
            group DRAIN_BGP_UNDERLAY {
                maintenance-profile DRAIN_BGP
                maintenance-mode {
                    admin-state disable
                }
                members {
                    bgp {
                        network-instance default {
                            peer-group [
                                UNDERLAY
                            ]
                        }
                    }
                }
            }
            profile DRAIN_BGP {
                bgp {
                    import-policy REJECT_ALL
                    export-policy REJECT_ALL
                }
            }
        }
    }
--{ + running }--[  ]--
A:syd1-pd1-sp1# 
Current mode: + running
```

- NOS-integrated mechanism for applying configuration designed for maintenance
  - E.g. BGP Import/Export Policies
- Policies are completely configurable
- Multiple Maintenance Groups are possible
- One config item per group to enable or disable.

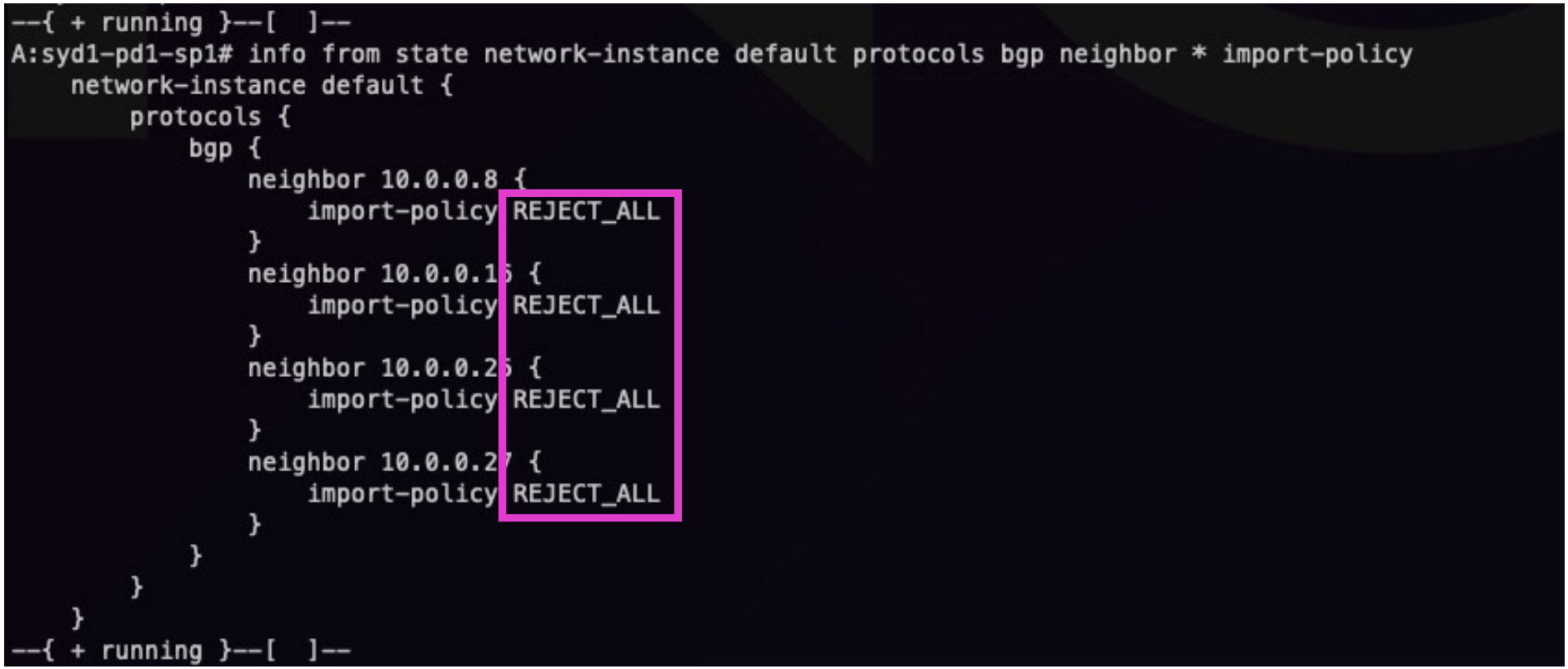
Underlay BGP Neighbours

```
--{ + running }--[  ]--
A:syd1-pd1-sp1# show network-instance default protocols bgp neighbor
-------------------------------------------------------------------------------------------------------------------------------------------
BGP neighbor summary for network-instance "default"
Flags: S static, D dynamic, L discovered by LLDP, B BFD enabled, - disabled, * slow
-------------------------------------------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------------------------------------------
+-----------------+-------------------------+-----------------+------+---------+-------------+--------------+------------+--------------------+
|    Net-Inst     |          Peer           |      Group      | Flag | Peer-AS |    State    |    Uptime    | AFI/SAFI   |     [Rx/Active/Tx] |
|                 |                         |                 |  s   |         |             |              |            |                    |
+=================+=========================+=================+======+=========+=============+==============+============+====================+
| default         | 10.0.0.8                | UNDERLAY        | S    | 4210000 | established | 28d:2h:48m:4 | ipv4-      | [1/1/3]            |
|                 |                         |                 |      | 001     |             | 9s           | unicast    |                    |
| default         | 10.0.0.16               | UNDERLAY        | S    | 4210000 | established | 28d:2h:22m:7 | ipv4-      | [1/1/3]            |
|                 |                         |                 |      | 002     |             | s            | unicast    |                    |
| default         | 10.0.0.25               | UNDERLAY        | S    | 4210000 | established | 10d:1h:12m:4 | ipv4-      | [1/1/3]            |
|                 |                         |                 |      | 101     |             | 0s           | unicast    |                    |
| default         | 10.0.0.27               | UNDERLAY        | S    | 4210000 | established | 28d:20h:1m:5 | ipv4-      | [1/1/3]            |
|                 |                         |                 |      | 102     |             | 0s           | unicast    |                    |
+-----------------+-------------------------+-----------------+------+---------+-------------+--------------+------------+--------------------+
-------------------------------------------------------------------------------------------------------------------------------------------
Summary:
4 configured neighbors, 4 configured sessions are established,0 disabled peers
0 dynamic peers
```

Enabling Maintenance Group

```
--{ + running }--[  ]--
A:syd1-pd1-sp1# enter candidate
--{ + candidate shared default }--[  ]--
A:syd1-pd1-sp1# set system maintenance group DRAIN_BGP_UNDERLAY maintenance-mode admin-state enable
--{ +* candidate shared default }--[  ]--
A:syd1-pd1-sp1# diff
      system {
          maintenance {
              group DRAIN_BGP_UNDERLAY {
                  maintenance-mode {
-                     admin-state disable
+                     admin-state enable
                  }
              }
          }
      }
--{ +* candidate shared default }--[  ]--
A:syd1-pd1-sp1# commit now
All changes have been committed. Leaving candidate mode.
--{ + running }--[  ]--
A:syd1-pd1-sp1# show network-instance default protocols bgp neighbor
-------------------------------------------------------------------------------------------------------------------------------------------------------------
BGP neighbor summary for network-instance "default"
Flags: S static, D dynamic, L discovered by LLDP, B BFD enabled, - disabled, * slow
-------------------------------------------------------------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------------------------------------------------------------
+-----------------+------------------------+----------------+------+---------+-------------+--------------+-----------+--------------------+
|    Net-Inst     |          Peer          |     Group      | Flag | Peer-AS |    State    |    Uptime    | AFI/SAFI  |    [Rx/Active/Tx]  |
|                 |                        |                |  s   |         |             |              |           |                    |
+=================+========================+================+======+=========+=============+==============+===========+====================+
| default         | 10.0.0.8               | UNDERLAY       | S    | 4210000 | established | 28d:2h:49m:4 | ipv4-     | [4/0/0]            |
|                 |                        |                |      | 001     |             | 3s           | unicast   |                    |
| default         | 10.0.0.16              | UNDERLAY       | S    | 4210000 | established | 28d:2h:23m:1 | ipv4-     | [4/0/0]            |
|                 |                        |                |      | 002     |             | s            | unicast   |                    |
| default         | 10.0.0.25              | UNDERLAY       | S    | 4210000 | established | 10d:1h:13m:3 | ipv4-     | [4/0/0]            |
|                 |                        |                |      | 101     |             | 4s           | unicast   |                    |
| default         | 10.0.0.27              | UNDERLAY       | S    | 4210000 | established | 28d:20h:2m:4 | ipv4-     | [4/0/0]            |
|                 |                        |                |      | 102     |             | 4s           | unicast   |                    |
+-----------------+------------------------+----------------+------+---------+-------------+--------------+-----------+--------------------+
-------------------------------------------------------------------------------------------------------------------------------------------------------------
```

Neighbour Import Statement State



Pre-State Tests (post MG)

Custom Tests

```python
import pytest
from utils.device_utils import *

devices = [
  "dcfabric-syd1-pd1-l1",
  "dcfabric-syd1-pd1-l2",
  "dcfabric-syd1-pd1-sp1",
  "dcfabric-syd1-pd1-sp2",
  "dcfabric-syd1-ss1",
  "dcfabric-syd1-ss2",
]

@pytest.mark.parametrize('device', devices)
def test_maintenance_group_not_active(device):
  maint_groups = get_maintenance_groups(device)
  active_groups = 0
  for group in maint_groups:
    if group.get("maintenance-mode").get("admin-state") == "enable":
      active_groups += 1

  assert active_groups == 0
```

Custom Tests

```
(venv) root@containerlab:/home/tim/ausnog-2024/nuts# pytest ./tests/test_maintenance_groups.py
Test session starts (platform: linux, Python 3.10.12, pytest 7.4.4, pytest-sugar 1.0.0)
rootdir: /home/tim/ausnog-2024/nuts
configfile: pytest.ini
plugins: nuts-3.4.0, anyio-4.4.0, sugar-1.0.0
collected 6 items

 tests/test_maintenance_groups.py ✓✓                                                33%

_____________________________ test_maintenance_group_not_active[dcfabric-syd1-pd1-sp1] _____________________________

device = 'dcfabric-syd1-pd1-sp1'

    @pytest.mark.parametrize('device', devices)
    def test_maintenance_group_not_active(device):
      maint_groups = get_maintenance_groups(device)
      active_groups = 0
      for group in maint_groups:
        if group.get("maintenance-mode").get("admin-state") == "enable":
          active_groups += 1

>     assert active_groups == 0
E     assert 1 == 0

tests/test_maintenance_groups.py:21: AssertionError

 tests/test_maintenance_groups.py ×✓✓✓                                              100%
=========================================== short test summary info ============================================
FAILED tests/test_maintenance_groups.py::test_maintenance_group_not_active[dcfabric-syd1-pd1-sp1] - assert 1 == 0

Results (1.30s):
       5 passed
       1 failed
         - tests/test_maintenance_groups.py:13 test_maintenance_group_not_active[dcfabric-syd1-pd1-sp1]
```

What about the EVPN Service?

```python
import pytest
import itertools
from utils.device_utils import *

devices = ["dcfabric-syd1-pd1-l1", "dcfabric-syd1-pd1-l2"]
evpn_mac_types = ["evpn", "learnt"]

@pytest.mark.parametrize('device,mac_type', itertools.product(devices, evpn_mac_types))
def test_evpn_bridge_table_learnt_macs(device, mac_type):
    bridge_table = get_bridge_table(device)
    mac_count = 0
    for mac in bridge_table:
        if mac.get("type") == mac_type:
            mac_count += 1

    assert mac_count > 0
```

```
(venv) root@containerlab:/home/tim/ausnog-2024/nuts# pytest ./tests/test_evpn_bridge_tables.py
Test session starts (platform: linux, Python 3.10.12, pytest 7.4.4, pytest-sugar 1.0.0)
rootdir: /home/tim/ausnog-2024/nuts
configfile: pytest.ini
plugins: nuts-3.4.0, anyio-4.4.0, sugar-1.0.0
collected 4 items

 tests/test_evpn_bridge_tables.py ////                                    100%

Results (0.90s):
       4 passed
```

Do Maintenance, Undrain

- Shut Interfaces on the box (fully isolate)
- Do your maintenance:
  - Software Upgrade
  - Hardware Swap (complete/partial)
  - Configuration Testing
  - Load Testing
- Load device back up, with maintenance group still active.
- Enable all interfaces*
- Test for Maintenance Groups
- Test for EVPN Service MACs

```
(venv) root@containerlab:/home/tim/ausnog-2024/nuts# pytest ./tests/*.py
Test session starts (platform: linux, Python 3.10.12, pytest 7.4.4, pytest-sugar 1.0.0)
rootdir: /home/tim/ausnog-2024/nuts
configfile: pytest.ini
plugins: nuts-3.4.0, anyio-4.4.0, sugar-1.0.0
collected 10 items

 tests/test_evpn_bridge_tables.py ✓✓✓✓                                    40%
 tests/test_maintenance_groups.py ✓✓✓✓✓✓                                  100%

Results (2.00s):
      10 passed
```

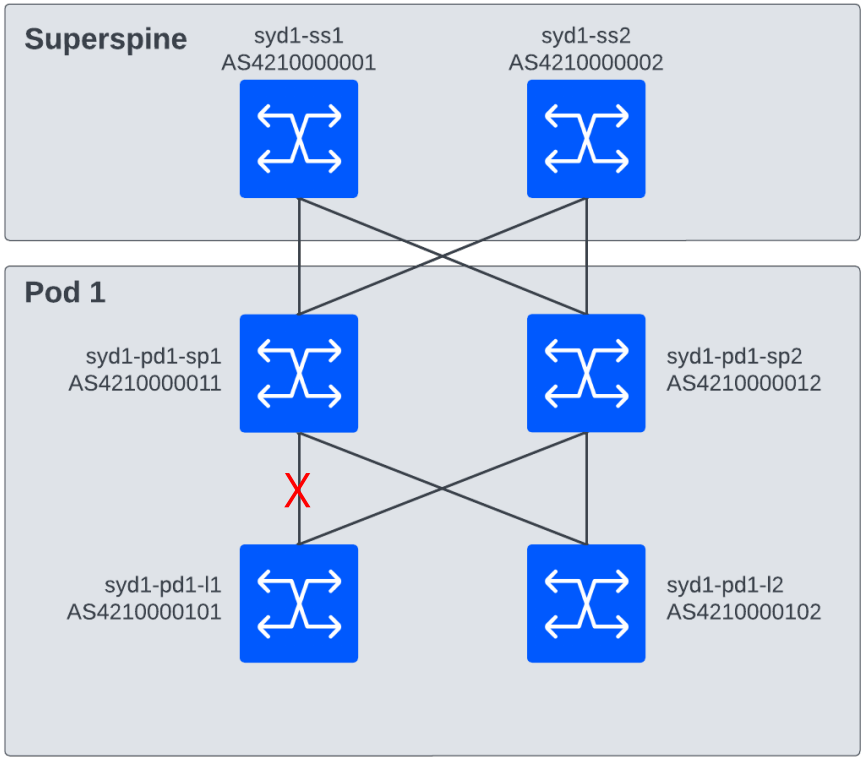
All good right…?

Run our pre-state tests

Looks like the link between leaf1 and spine1 is down…

Example Network

SRLinux-based Data Centre Fabric – EVPN-VXLAN



Passing Tests?

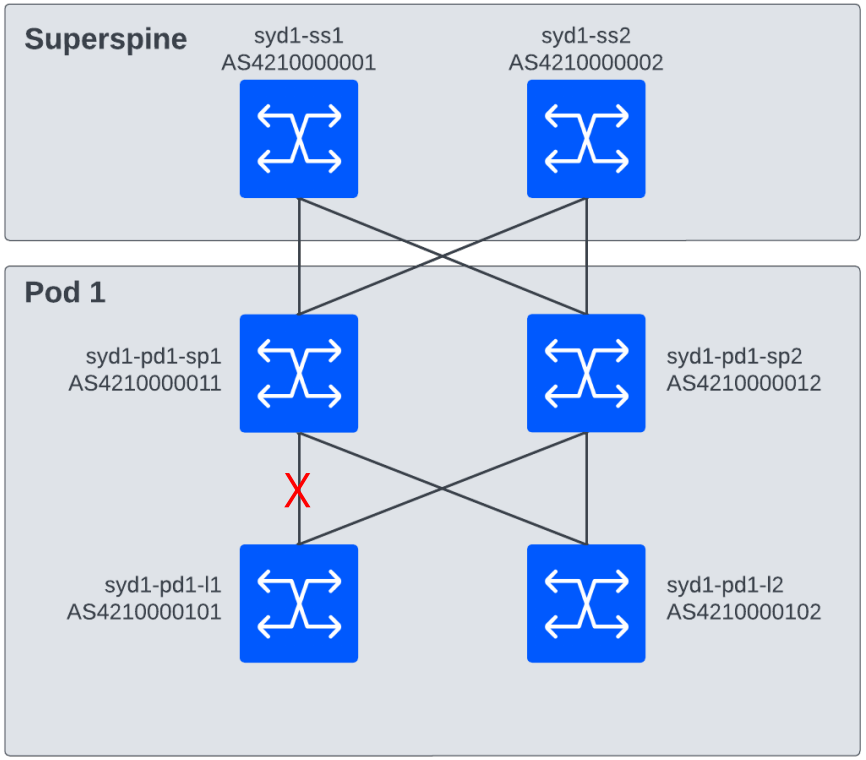
```
(venv) root@containerlab:/home/tim/ausnog-2024/nuts# pytest ./tests/*.py
Test session starts (platform: linux, Python 3.10.12, pytest 7.4.4, pytest-sugar 1.0.0)
rootdir: /home/tim/ausnog-2024/nuts
configfile: pytest.ini
plugins: nuts-3.4.0, anyio-4.4.0, sugar-1.0.0
collected 10 items

 tests/test_evpn_bridge_tables.py ✓✓✓✓                                    40%
 tests/test_maintenance_groups.py ✓✓✓✓✓✓                                  100%

Results (2.00s):
      10 passed
```

Example Network

SRLinux-based Data Centre Fabric – EVPN-VXLAN



Fix the issue and re-run tests

```
--{ + candidate shared default }--[  ]--
A:syd1-pd1-sp1# set interface ethernet-1/1 admin-state enable
--{ +* candidate shared default }--[  ]--
A:syd1-pd1-sp1# diff
      interface ethernet-1/1 {
-         admin-state disable
+         admin-state enable
      }
--{ +* candidate shared default }--[  ]--
A:syd1-pd1-sp1# commit now
All changes have been committed. Leaving candidate mode.
--{ + running }--[  ]--
A:syd1-pd1-sp1#
Current mode: + running
```

```
(venv) root@containerlab:/home/tim/ausnog-2024/nuts# pytest
Test session starts (platform: linux, Python 3.10.12, pytest 7.4.4, pytest-sugar 1.0.0)
rootdir: /home/tim/ausnog-2024/nuts
configfile: pytest.ini
plugins: nuts-3.4.0, anyio-4.4.0, sugar-1.0.0
collected 322 items

 tests/test_basic_lldp_neighbours.yaml ✓✓✓✓                                                                1%
 tests/test_evpn_bridge_tables.py ✓✓✓✓                                                                      2%
 tests/test_generated_prestate_fabric.yaml ✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓ssss✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓ 23%
                                                ✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓ssss✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓ 43%
                                                ✓✓ssss✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓ssss✓✓✓✓✓ 63%
                                                ✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓ssss✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓ 83%
                                                ✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓ssss✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓✓ 98%
 tests/test_maintenance_groups.py ✓✓✓✓✓✓                                                                  100%

Results (13.98s):
     298 passed
      24 skipped
(venv) root@containerlab:/home/tim/ausnog-2024/nuts#
```

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